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Publication date:
2017

Document Version
Peer reviewed version

Micro injection moulding process optimization of an ultra-small POM three-dimensional component

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Abstract

Replication-based manufacturing processes are a cost effective method for producing complex and net-shaped components [1]. Micro injection moulding has a prominent place among them for its capability of accurately and precisely produce micro plastic parts in large production scale [2], [3]. In this study, the optimization of the micro injection moulding process of an ultra-small (volume: 0.07 mm3; mass: 0.1 mg) three-dimensional Polyoxymethylene (POM) micro component for medical applications (see Figure 1) is presented. Preliminary experiments highlighted the need for venting channels in order to facilitate the evacuation of air from the micro cavity, allowing the consistent achievement of complete filling. If, on one hand, the implemented venting channel (depth: 4 µm) solved the issue, on the other, it caused the formation of a micro-scaled flash on the part. In order to optimize the part geometry with respect to design specifications, the flash areal size was utilized as quality indicator. A design of the experiments approach was carried out in order to study the effects of melt temperature, mould temperature, holding pressure and injection speed. For this task, a two-level full factorial design was selected. The flash size (i.e. flash area) of each moulded part was characterized and measured using a state-of-the-art 3D focus variation microscope featuring sub-micrometric lateral resolution (see Figure 2). The results of the analysis show that the flash can be successfully used to highlight the most significant process parameters with respect to the part quality (see Figure 3). Being the flash area also measurable using an appropriate 2D camera, this opens the door to future in-line and cost-effective dimensional quality assurance.

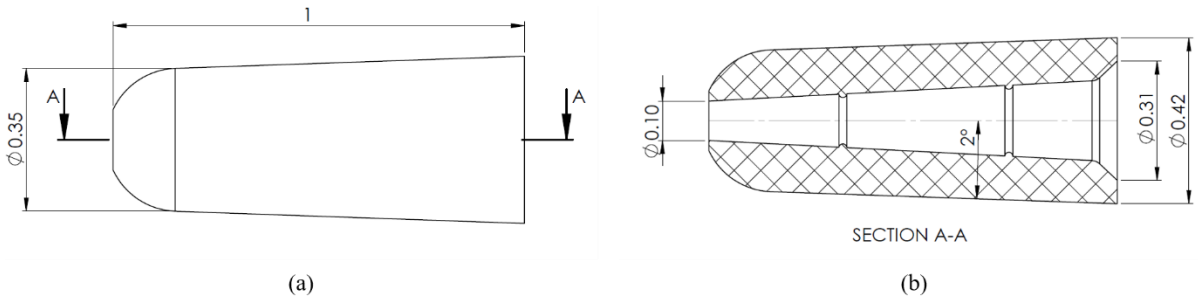

Figure 1. Geometry of the micro component

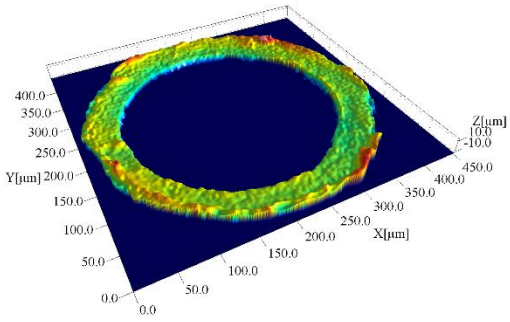

Figure 2. 3D acquisition of flash area

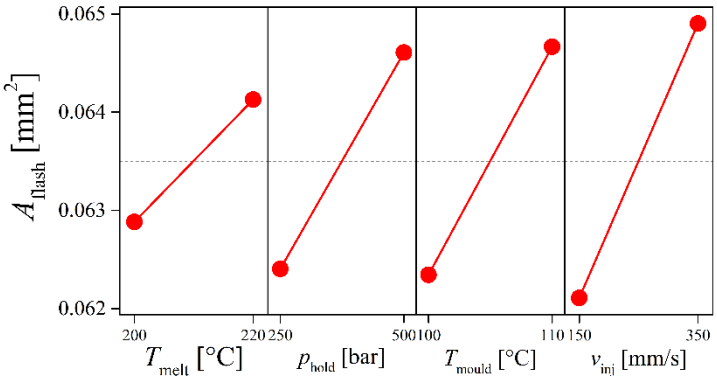

Figure 3. Main effects plot of flash area

Acknowledgements

This research work was undertaken in the context of MICROMAN project ("Process Fingerprint for Zerodefect Net-shape MICROMANufacturing", http://www.microman.mek.dtu.dk/). MICROMAN is a European Training Network supported by Horizon 2020, the EU Framework Programme for Research and Innovation (Project ID: 674801).

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